Biomass and fate of grain in harvested and unharvested agricultural fields for waterfowl in Tennessee
M.S. Proposal

North American waterfowl populations declined to record lows in the mid-1980s.
Why?
• Long-term drought
• Pollution, urbanization
• Degradation & destruction of wetlands!

1986: NAWMP created
• Joint ventures act regionally
• In non-breeding areas, focus is on providing foraging habitat
  – Rebuild lipid reserves lost in migration
  – Return north in good condition to breed

Photo: Michael Walsh
Seeds!

- Waste grain: grain left in the field following harvest.
Quantifying Duck Energy-Days

**Prince** 1979

**Reinecke et al.** 1989

**Reinecke and Loesch** 1996

\[
D\text{ED} = \frac{\text{Food Available (g [dry]) \times TME (kcal/g [dry])}}{\text{Daily Energy Requirement (kcal/day)}}
\]

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Nature vs. Agriculture

Reinecke and Kaminski (2006) LMJV estimates

<table>
<thead>
<tr>
<th></th>
<th>TME (kcal/g)</th>
<th>Biomass (kg/ha)</th>
<th>DEDs/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>3.67</td>
<td>150</td>
<td>1,250</td>
</tr>
<tr>
<td>Grain Sorghum</td>
<td>3.49</td>
<td>150</td>
<td>1,188</td>
</tr>
<tr>
<td>Soybean</td>
<td>2.65</td>
<td>60</td>
<td>89</td>
</tr>
<tr>
<td>Acorns</td>
<td>2.76</td>
<td>79-166</td>
<td>270-1,087</td>
</tr>
<tr>
<td>Moist-soil</td>
<td>2.47</td>
<td>600</td>
<td>4,624 X</td>
</tr>
</tbody>
</table>

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Why study waste grain in the Southeast?

- Changes in harvest efficiency and timing
- Previous studies from geographic areas that differ greatly from SE.
- In accordance with the NAWMP, a major effort each year is to calculate DEDs.
Objectives:

1. Estimate the biomass of agricultural seeds in harvested and unharvested corn, grain sorghum and soybean fields from harvest through January.
2. Quantify the amount, rate and fate of grain loss in agricultural fields from harvest to January.
3. Compare January biomass estimates with those currently used by the LMVJV.
4. Compare grain biomass and fates among four climate zones in TN.
5. Compare the biomass of waste grain among state, federal and privately-owned agricultural lands.
6. Relate microclimate conditions to rates of grain decomposition and germination.

PLOT LOCATIONS

Federal land: TNWR
TNWR

- Corn and soybean: \( n = 4 \) fields/species

4 plots per field (2 harvested, 2 unharvested):

- Harvested
- Unharvested

Tennessee NWR
Corn and Soybean Fields

\( n_{\text{tot}} = 8 \) harvested and 8 unharvested plots/species

Photo: Drew Wirwa
TNWR

Grain Sorghum:

\[ n = 4 \text{ fields} \]

None harvested

State and Private Land:

Grain sorghum: production limited to west TN.

\[ n = 5 \text{ fields in West} \]

Corn and Soybeans: statewide production

\[ 4 \text{ fields each per region statewide} \]

\[ n = 16 \text{ fields per grain species} \]

METHODS
Plot Setup:

- **a)** Experimental unit: 0.202 ha grid overlaid for random generation of the three subsampling locations.
- **b)** Nested design of subsampling plots (Frederick et al. 1984)
- **c)** Location and design of microclimate "fate" plots of harvest corn and grain sorghum.

Both "ear" and "kernel" plots were sampled for harvested corn and grain sorghum. Only the small plot was sampled in harvested soybean fields and for all unharvested crops.

All fields were sampled every 4 weeks post-harvest/drydown.

Three subsampling plots were randomly selected:

**Searching for corn cobs...**

All corn cobs with >10 kernels and sorghum seed heads >5 cm in length were collected.

**Soybean subsampling plot:**

The Richards et al. method was adopted to count the soybean seeds.
Sample Processing

1. Thresh seeds
2. Store in freezer
3. Dry to constant mass
4. Weigh

QUANTIFYING SEED FATE

Methods:

- Microclimate subplot
  - Center of exp. unit
  - Consists of open and exclosed plot.
Methods:

- 100 seeds scattered under granivore exclosure
- 100 seeds scattered in open plot 5 m away
- Counted every 4 weeks from harvest through Jan.
- Difference between exclosed and open plots = Depredation

Radiation shield housing HOBO® Weather Logger
- Measures temperature & relative humidity
- Used to quantify the influence of microclimate on seed loss and fate.
Preliminary Results:

Analyses

- January biomass estimates
  - Means and standard errors (SE)
  - Qualitatively compared to estimates currently used by the LMVJV.
- Biomass of seed: temporal declines
  - Repeated-measures ANOVA
  - Tukey’s multiple comparison test.
- Fate of seed in microclimate plots:
  - Overall percent lost to each fate

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fields (n)</th>
<th>Biomass (kg/ha) mean</th>
<th>SE</th>
<th>DED/ha estimate (DED/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>24</td>
<td>34.60</td>
<td>13.91</td>
<td>194.45</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>5</td>
<td>11.22</td>
<td>4.31</td>
<td>194.45</td>
</tr>
<tr>
<td>Soybean</td>
<td>24</td>
<td>16.90</td>
<td>4.30</td>
<td>194.45</td>
</tr>
</tbody>
</table>

“Giving-up density” (Rutka 2004) = 50 kg/ha
- DEDs functionally zero
- Corn and Soybean: 92% of fields below
- Grain Sorghum: 100% of fields below
Corn Biomass: months post-harvest

Soybean Biomass: months post-harvest

Grain Sorghum Biomass: months post-harvest

P = 0.001

P = 0.22
Preliminary Results: Seed Fate

Corn Fate:
- 68% Intact
- 16% Germinated
- 10% Decomposed
- 6% Depredated

Soybean Fate:
- 40% Intact
- 35% Germinated
- 18% Decomposed
- 7% Depredated
Grain Sorghum Fate:

- 17% Depredated
- 22% Germinated
- 61% Decomposed
- 0% Intact

Note:
- Data represents individual seeds scattered on ground
  - Seed heads/cobs intact on ground
  - Seed heads/cobs on standing plants that were missed by combine

Summary:
- Corn: 194 DEDs/ha
  - 92% with 0 DEDs
  - Depredation!
- Soybean: 20 DEDs/ha
  - 92% with 0 DEDs
  - Germination and Decomposition
- Grain Sorghum: 0 DEDs/ha (100%)
  - Decomposition!
Management Recommendations:

- Delay harvest if possible
  - Fields may have little nutritional value to waterfowl at 1-2 months post-harvest

- Plant additional food plots
  - Delay bush-hogging of standing crops until birds arrive

- Increase waterfowl carrying capacity through management of natural wetlands (e.g., moist-soil impoundments)
  - Decomposition of moist-soil seeds is much slower compared with agricultural seeds.

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Questions?